KINEMATIC POSSIBILITIES FOR A MECHANISM WITH THREE RRR DYADS. GENERAL CASE

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Abstract. The paper deals with the kinematic possibilities of a mechanism with 7 elements, consisting of a leading element with rotating movement and 3 RRR dyads. Based on the projections method, analytical relations are obtained. Trajectories of some points are drawn, along with the diagrams depicting the variation of their co-ordinates. The studied mechanism has no particular features, covering general characteristics

Key words: mechanism, kinematical diagrams, trajectories.

1. INTRODUCTION

Through successive modifications of the sliders and modality to link the dyads, the inventors can create 1,234,620 mechanisms with one leading element and 3 dyads [2]. The optimal design of a mechanism with 7 bars used by a press, through reversed Kinematics, is presented in [1].

In this paper, the method of contours is used and kinematical diagrams are provided. A mechanism with 7 elements based on bars and gear wheels is studied in [3].

Various diagrams concerning the laws for movement are obtained and the resulting trajectories are provided as well.

Studies on the trajectories that can be generated by a mechanism with 7 elements, using RRR dyads are presented in the following sections.

2. MECHANISM STRUCTURE

Fig. 1 depicts details on the mechanism building. The leading element AB, denoted by 1 is linked to the first dyad $B_1C_1D_1$, consisting of the elements 2 and 3. This dyad is also linked to the basis, therefore the link is of type 1+0.

In the exit points of this dyad (E and G), the second dyad (EFG) is linked. It consists of the elements 4 and 5. The link is of type 2+3, which means that the second dyad is linked to the elements 2 and 3.

In the exit points of the 2nd dyad, (H and L) the 3rd dyad is linked, with the elements 6 and 7. The link is of type 4+5.

The mechanism symbolization is therefore R-RRR – 1+0 - RRR – 2+3 – RRR – 4+5.

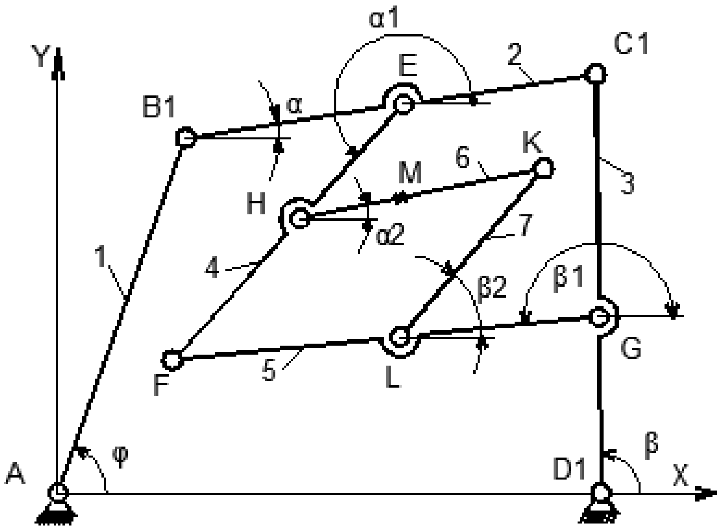

Fig. 1

3. MECHANISM KINEMATICS

Using the method of projections and Fig. 1, the following equations can be written:

$x_{B1} = AB_1.\cos\varphi$; $y_{B1} = AB_1.\sin\varphi$ (1)

$x_{C1} = x_{B1}+B_1C_1.\cos\alpha = x_{D1}+D_1C_1.\cos\beta$; $y_{C1} = y_{B1}+B_1C_1.\sin\alpha=y_{D1}+D_1C_1.\sin\beta$ (2)

$x_E=x_{B1}+B_1E\cos\alpha$; $y_E=y_{B1}+B_1E.\sin\alpha$ (3)

$x_G=x_{D1}+D_1G.\cos\beta$; $y_G=y_{D1}+D_1G.\sin\beta$ (4)

$x_F=x_E+EF.\cos\alpha_1=x_G+GF.\cos\beta_1$; $y_F=x_E+EF.\sin\alpha_1=x_G+GF.\sin\beta_1$ (5)

$x_H=x_E+EH.\cos\alpha_1$; $y_H=y_E+EH.\sin\alpha_1$ (6)

$x_L=x_G+GL.\cos\beta_1$; $y_L=y_G+GL.\sin\beta_1$ (7)

$x_K=x_H+HK.\cos\alpha_2+x_L+LK.\cos\beta_2$; $y_K=y_H+HK.\sin\alpha_2+x_L+LK.\sin\beta_2$ (8)

4. RESULTS

The sides and angles were considered as having the following values: AB_1=73; B_1C_1=81; D_1C_1=74; EF=67; GF=84; HK=46; LK=43; Y_D=0; EH=30; GL=39; HM=20; X_{D1}=106; D_1G=34; B_1E=43.

Fig. 2.a depicts the mechanism in the position φ=70°. The mechanism is similar toe that from Fig. 1, proving the correctness of program.

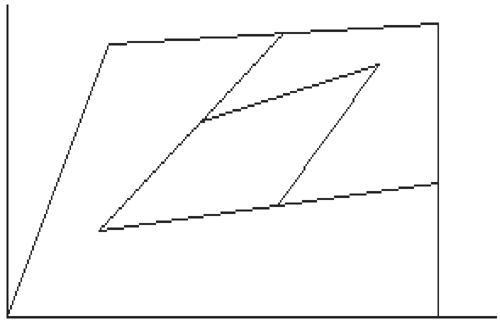

Fig. 2.a

The mechanism’s successive positions are depicted by Fig. 2.b. Pauses in mechanism’s operations are revealed.

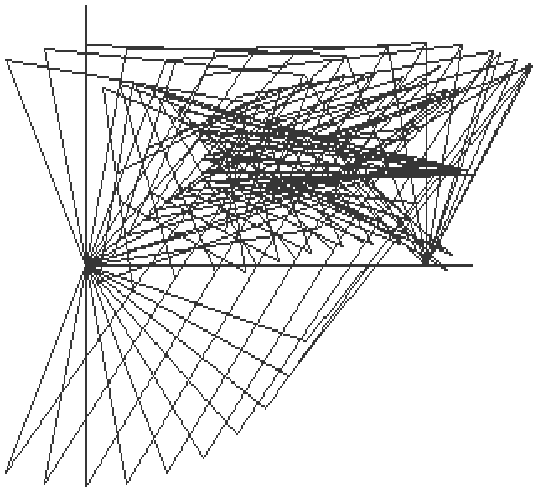

Fig. 2.b

Fig. 3 depicts the trajectories of ponts B_1 and C_1. One can notice that these circles are not complete. The explanation resides in the disobeying of Grashof’s conditions, responsible for the complete rotation of the crank. The diagrams for the variations of coordinates of points B_1 and C_1 are presented in Fig. 4.

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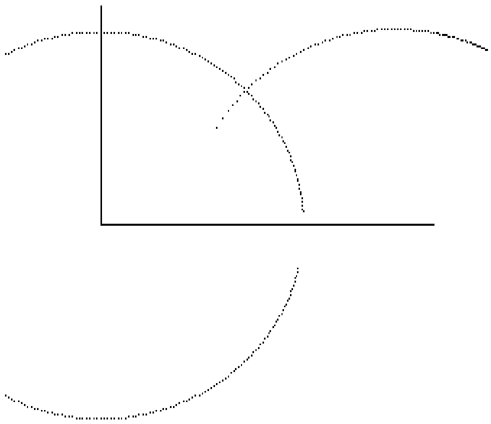

Fig. 3

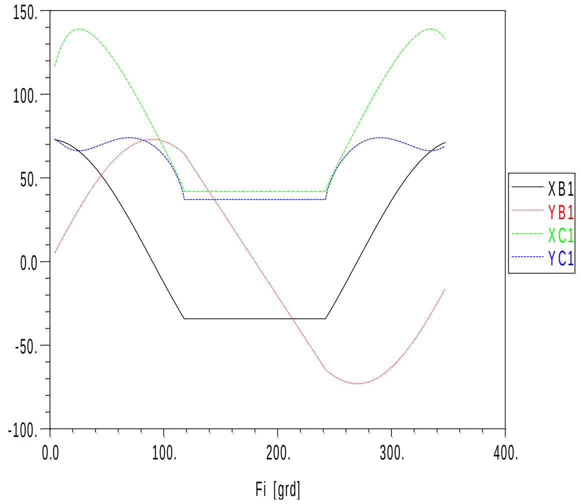

Fig. 4

Within the range φ=120°…240° the mechanism does not operate – linear segments appear within the diagrams (the program provides a straight line between the last point – corresponding to φ=120° and respectively the first point corresponding to φ=240°). The trajectories of points E and G are provided by Fig. 5 whilst the corresponding diagrams are depicted by Fig. 6. The point G moves along a circle and E describes a curve with loops at the endpoints of the subintervals in which the mechanism is non-operational. Fig. 6 reveals identical subintervals corresponding to pauses of mechanism.

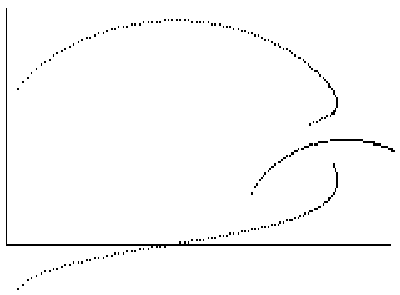

Fig. 5

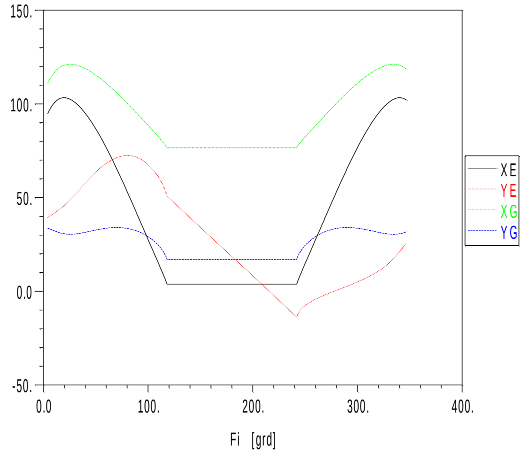

Fig. 6

The trajectories of points H and L, used to link the 2nd dyad, are provided by Fig. 7. The corresponding diagrams are given in Fig. 8.

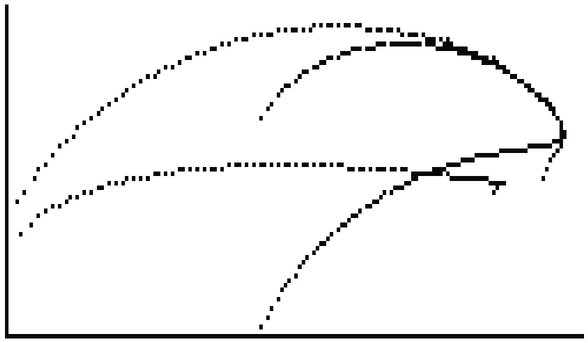

Fig. 7

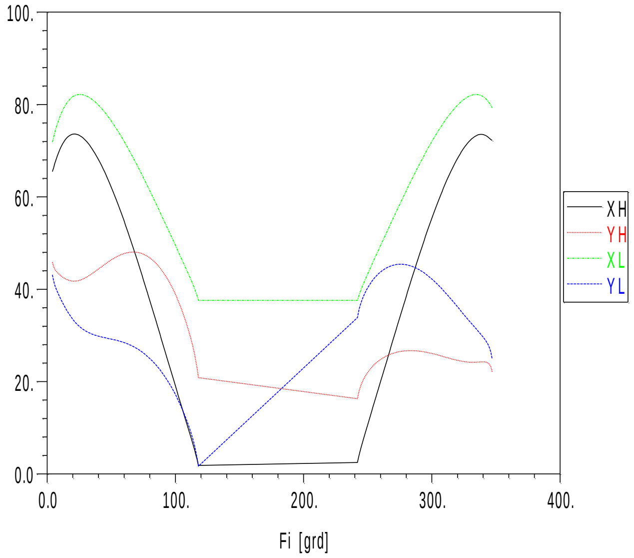

Fig. 8

Fig. 9 depicts the trajectories of points representing interest for this study: F - the left sided curve, K – the middle curve and M and right side curve. These curves are characterized by a high degree and exhibit variations of sense.

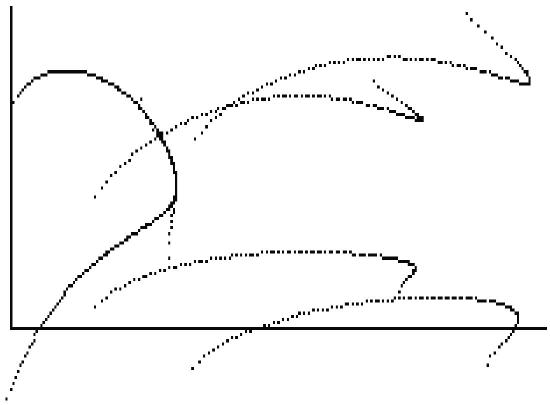

Fig. 9

The diagrams depicted by Fig. 10 present the variations of coordinates corresponding to the points F and K. Each of these curves present two distinct branches, because the Grashof conditions are not fulfilled.

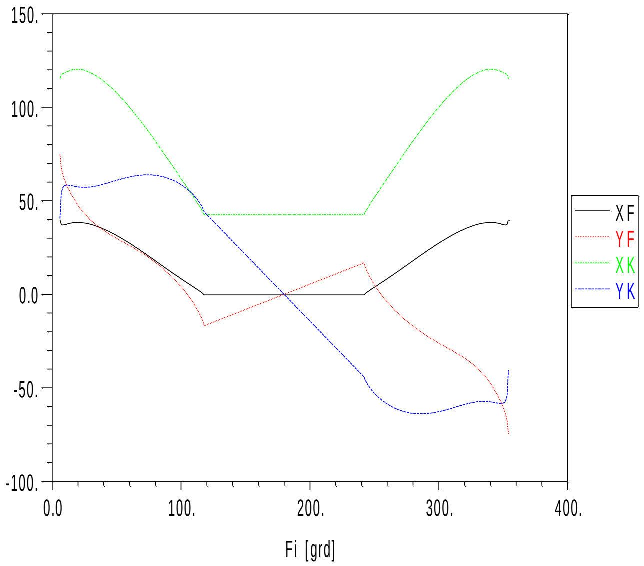

Fig. 10

5. CONCLUSIONS

- At an ordinary articulated four-sided mechanism for which the Grashof conditions are not fulfilled, there is a subrange of the cycle in which the mechanism cannot operate, irrespective of the dyads connecting it.
- The 2nd and 3rd dyads may also block the movement for certain subintervals, depending on the lengths of their elements.
- Trajectories of various points and the diagrams corresponding to the variations of their coordinates were obtained.
- Despite their significantly high degrees, the resulting trajectories are not impressive.

BIBLIOGRAPHY

[1] Hui-Li, Lihui Fu-Yuping Zhang – Optimum design a hybrid-driven mechanical press based on inverse kinematics. In: Strojniski vestinic – Journal of Mechanical Engineering 56, 2010, pp. 301-306.
[2] Popescu, I. – Mecanisme. Noi algoritmi şi programe. Reprografia Universităţii din Craiova, 1997.
[3] Ren-Chung Soong, Kuei-Shu Hsu, Feng-Tsai Weng – A programmable geared seven-bar mechanism for mechanical forming presses. In: Journal for Chinese Society of Mechanical Engineers, vol. 29, no.1, 2008, pp. 61-67.